Wind Speed Predictions with an Analog-based Method in Complex Terrain

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Introduction

The first step to build an analog ensemble (AnEn) method is the search for similar past predictions (i.e., analogs) across several variables (e.g., wind speed, wind direction, temperature) to the current prediction[1]. It is computed as follows:

\[ (\text{AnEn})_{\text{med}} = \sum_{a=1}^{N_a} \left( \frac{1}{N_a} \sum_{i=1}^{N_a} (F_{a,i} - \text{AE}_{a})^2 \right) \]

The measurements corresponding to the anologs form the AnEn. AnEn can be used to generate deterministic (e.g., the AnEn mean or median) and probabilistic short- or medium-range forecasts.

Methods

• Training period: year 2010 & 2011.
• Verification period: year 2012.
• Starting models:
  i. ALADIN 8 km (A8): 37 levels; 240 x 216 grid points; 72-hour forecast, 3 hours output; hydrostatic.
  ii. ALADIN 2 km (A2): 37 levels; 450 x 450 grid points; 24-hour forecast; 1 hours output; non-hydrostatic.
  iii. ODA 2 km (OA): 15 levels; 450 x 450 grid points; 72-hour forecast; 3 hours output; hydrostatic.
• 14 stations divided into 3 groups (Fig1):
  i. Coastal area with largest wind speeds (bora)
  ii. Mountain area
  iii. Continental part with smallest wind speeds

Objectives

• To evaluate performance of AnEn methods, compared to starting NWP model.
• To test adjustment to terrain complexity and sensitivity to horizontal resolution of starting NWP model.

Results

• AnEn deterministic forecasting produces the best results with 10-15 AnEn members (RMSE reduction up to 30%) (Fig2).
• Even though average bias for starting model is very small, its reduction can be seen if dependency on lead time is considered (Fig3).
• Different AnEn methods have similar dependency on lead time as KF, while reducing RMSE and improving correlation even more, especially in complex terrain with higher winds speeds (group 1).
• Results for AnEn forecasting started with different models differ much less than ones for the starting models themselves (Fig4). They show that AnEn methods often work best with A2 starting model.
• Frequency bias (Fbias) shows that moderate wind speeds (category 2) are forecasted too often, while strong winds to rarely (Fig5).
• Strong wind seems to be the hardest category to predict. Critical success index (CSI) suggests that there is a slight improvement in AnEn forecasting high wind speed category 3 (better starting model (Fig6)).

Conclusions

An analog ensemble method adjusts to all sorts of terrain (especially AE mean). It reduces RMSE and bias, while improving RICC. In most cases starting model with 8-km horizontal resolution produces the best results, but using higher resolution improves accuracy for high wind speed forecasting.

References